

REMARKS/ARGUMENTS

Upon careful and complete consideration of the Office Action dated December 16, 2005, applicants have amended the claims which, when considered in conjunction with the comments herein below, are deemed to place the present application into condition for allowance. Favorable reconsideration of this application, as amended, is respectfully solicited.

The Office Action initially rejected claims 11 and 12 under 35 U.S.C. §112, second paragraph, as allegedly being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. In particular, the Examiner correctly noted that claims 11 and 12 depended from themselves. Both claims have been amended to correct the inadvertent error, with claim 11 now depending upon claim 10, and claim 12 now depending upon claim 11. Based on the amendments made to claims 11 and 12, applicants respectfully request that the rejection of said claims under 35 U.S.C. §112 be withdrawn.

The Office Action next rejected claims 1-2, 5-12, 16-18, 20-24, 27 and 29-30 under 35 U.S.C. §102(b) alleging that the subject matter of these claims was anticipated by U.S. Patent No. 6,040,021 to Miyamoto (hereinafter referred to as "Miyamoto").

As amended, the present invention is directed to a method of making an interconnect structure comprising: the steps of (1) depositing a titanium layer on an interconnect structure having one or more contact openings which expose one or more silicide regions; (2) subjecting said deposited titanium layer to an in-situ plasma nitridization process; (3) depositing at least one layer of titanium nitride on said in-situ plasma-treated titanium layer by thermally decomposing a titanium-containing precursor

and a nitrogen-containing precursor; and (4) filling said contact openings with tungsten.

Claim 1 has been amended by incorporating the subject matter of original claim 16 and the fact that the “at least one titanium nitride layer” is deposited by a CVD process involving “thermally decomposing a titanium-containing precursor and a nitrogen-containing precursor” (see paragraph [0036] of the subject specification for support).

It is respectfully submitted that Miyamoto does not teach or suggest the deposition of such a layer by said process and, in fact, teaches away from such deposition. Miyamoto relates to a plasma CVD formation process for a metal nitride film intended to reduce the amount of a halogen element remaining in the film. The process of Miyamoto involves forming the metal film on the substrate by plasma CVD, nitriding the metal film by plasma nitriding, and repeating a plurality of times said step of forming the metal film and said step of nitriding the metal film thus formed to result in a metal nitride film having a specific thickness.

The Examiner’s attention is respectfully directed to column 6 of Miyamoto, lines 59-66 wherein it is stated that the “feature of the process of forming a metal nitride film according to ...[Miyamoto]... lies in that a metal nitride film is not directly formed on a substrate having a stepped portion, but a metal nitride film having a specific thickness and a specific shape is formed by repeating a step of forming a metal film into a good shape by the plasma CVD process or a specific sputtering process and a step of nitriding the metal film by plasma nitriding.”

This is a completely different process from that of the present invention which, after *in-situ* plasma nitriding the titanium layer, deposits at least one further titanium nitride level by a thermal CVD process, i.e. by thermally decomposing a titanium-

containing precursor and a nitrogen-containing precursor. Added to this distinction is the fact that Miyamoto actually teaches away from the use of any such thermal CVD process.

The Examiner's attention is directed to column 1, lines 56-67 whereat Miyamoto indicates that the shape of the film formed by thermal CVD is conformal. "To be more specific, the film is uniformly deposited on both a bottom surface and a side wall of the contact hole, so that the opening width of the contact hole is made narrow. This makes it difficult to bury the contact hole with tungsten or the like." Miyamoto then goes on to describe its process which copes with this inconvenience caused by the thermal CVD process.

The Examiner's attention is further directed to column 17 of Miyamoto, lines 54-58 where Miyamoto specifically states that "[t]he shape of the TiN film 51 **cannot be achieved by the method of forming a TiN film by thermal CVD** in which the TiN film is formed such that thicknesses thereof at a side wall and a bottom portion of the contact hole are nearly equal to each other." [emphasis added]

It is respectfully submitted that it is axiomatic that anticipation under Section 102 requires that the prior art reference disclose every element of the claim. In re King, 801 F.2d 1324, 1326, 231 U.S.P.Q. 136, 138 (Fed. Cir. 1986). Thus, there may be no differences between the subject matter of the claim and the disclosure of the prior art reference. Stated in another way, the reference must contain within its four corners adequate directions to practice the invention. The corollary of this rule is equally applicable. The absence from the reference of any claimed element negates anticipation. Kloster Speedsteel AB v. Crucible Inc., 793 F.2d 1565, 1571, 230 U.S.P.Q. 81, 84 (Fed. Cir. 1986).

Accordingly, it is submitted that Miyamoto does not teach the method of making the interconnect structure as now found in claim 1. That is, Miyamoto does not teach the deposition of a metal nitride film by a thermal CVD process following the plasma nitriding step. As demonstrated above, Miyamoto actually teaches away from the use of said step. As such, Miyamoto does not anticipate the claimed invention and the rejection of the claims based on 102(b) must fall. Clearly King and Kloster Speedsteel show that Miyamoto falls short of the anticipation standard of 35 U.S.C. §102(b).

The rejection of claims 2, 5-12, 16-18 and 20, all claims dependent upon the main claim, are also not anticipated by Miyamoto for the same reasons that apply to claim 1. It is noted that claims 21 and 22 have been deleted, while independent claim 23 has been amended similarly to claim 1 and is similarly distinguished from Miyamoto.

Based on the amendments made to the claims, and the arguments submitted above, it is respectfully requested that the 102 (b) rejections of claims 1-2, 5-12, 16-18, 20-24, 27 and 29-30 based on Miyamoto be withdrawn.

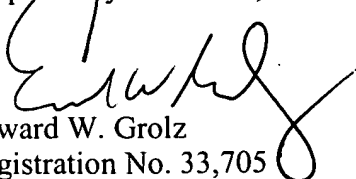
The Office Action goes on to reject claims 3-4 and 25-26 under 35 U.S.C. §103(a) as being unpatentable over Miyamoto in view of U.S. Patent No. 6,573,571 to Li (hereinafter referred to as “Li”). Li has been cited for the purpose of teaching other metals that may be used in a metal silicide region. As Li does not overcome the deficiency of Miyamoto discussed above, i.e. the skilled artisan relying on Miyamoto would not deposit further TiN layers using a thermal CVD process in accordance with the present invention, this rejection of the claims must also fall. Consequently, it is respectfully requested that the rejection of claims 3-4 and 25-26 under 35 U.S.C. §103(a) be withdrawn as well.

Next, the Office Action rejects claims 13-15 under 35 U.S.C. §103(a) as being unpatentable over Miyamoto in view of U.S. Patent No. 6,274,496 to Leusink (hereinafter referred to as “Leusink”). Leusink has been cited for the purpose of teaching the reaction times required to form a desired thickness of the resulting metal nitride film. As was the case with Li discussed above, Leusink also does not overcome the deficiency of Miyamoto discussed above, i.e. the skilled artisan relying on Miyamoto would not deposit further TiN layers using a thermal CVD process in accordance with the present invention. This rejection of the claims fails for the same reasons as the rejection involving Li. Consequently, it is respectfully requested that the rejection of claims 13-15 under 35 U.S.C. §103(a) be withdrawn.

The Office Action lastly rejects claims 19 and 28 under 35 U.S.C. §103(a) as being unpatentable over Miyamoto in view of U.S. Patent No. 6,316,353 to Selsley (hereinafter referred to as “Selsley”). Selsley has been cited for the purpose of teaching the specifically claimed titanium nitride film thickness. For the same reasoning as was applied to the rejections involving Li and Leusink, this rejection involving Selsley also does not overcome the identified deficiency of Miyamoto and the rejection of the claims must also fall. Consequently, it is respectfully requested that the rejection of claims 19 and 28 under 35 U.S.C. §103(a) be withdrawn.

Finally, it is further submitted that all the claims in the application as presently submitted contain patentable subject matter and a Notice of Allowance is earnestly solicited.

Respectfully submitted,


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